## REMARKS

Claims 1-4, 6-12, 14-21, and 23-82 are presented for further examination, with claims 1, 11, 17, 33, 49, 56, 63, 70, and 77-82 being independent. Independent claims 1, 11, 17, 33, 49, 56, 63, and 77-82 have been amended. Support for the amendments to the claims can be found in the application as originally filed, for example, at page 18, line 29 – page 19, line 1, and page 33, line 23 – page 34, line 5. No new matter has been added.

The rejection of claims 1-4, 6-10, 63-65, 67-69, 77, 79, 80, 81, and 82 were rejected under 35 U.S.C. § 103(a) over U.S. Patent Application Publication No. 2003/0129106 ("Sorensen") in view of U.S. Patent Application Publication No. 2002/0020429 ("Selbrede") and U.S. Patent Nos. 5,782,085 ("Steinwandel") and 5,460,689 ("Raaijmakers") is respectfully traversed.

Each of independent claims 1, 11, 17, 33, 49, 56, 63, and 77-82 now recites a method comprising, *inter alia*, **(1)** after igniting plasma, increasing the pressure, concentration, or flow rate of mixed gas, fluorine-containing species (*e.g.*, $NF_3$ or $F_2$), cleaning gas, or etching gas, ***while maintaining the plasma***; and **(2)** after increasing the pressure, concentration, or flow rate of mixed gas, fluorine-containing species (*e.g.*, $NF_3$ or $F_2$), cleaning gas, or etching gas, switching a mass flow controller used to supply the mixed gas, fluorine-containing species (*e.g.*, $NF_3$ or $F_2$), cleaning gas, or etching gas from a first mass flow controller having a first capacity to a second mass flow controller having a second capacity larger than the first capacity, ***while maintaining the plasma.***

As explained in the present application, "Once the plasma has been ignited, it becomes possible to move from a ignition point of plasma to a processing point where cleaning or etching processing is conducted, ***without extinguishing the plasma***, and efficient plasma process becomes necessary." (Emphasis Added; Page 18, Line 29 – Page 19, Line 1). Further, with reference to FIG. 13,

> [After igniting the plasma, in the case of switching] the mass flow controller 16a to the mass flow controller 16b of higher capacity at a point (8) on the path C . . . , there can occur a situation in which the flow rate and the total pressure are lowered to a point (9) with such

> switching of the mass flow controller, while it is possible to recover the state corresponding to a point (10) on the path C by driving the mass flow controller 16b of larger capacity. Thereby, according to the preset embodiment, ***the plasma . . . is not extinguished*** as long as the point (9) is located in the plasma sustaining region represented in FIG. 11.

(Emphasis Added; See, for example, Page 33, Line 26 – Page 34, Line 5). Additionally, "consider the case of increasing the flow rate of the Ar/$NF_3$ mixed gas first from the ignition point (1) of FIG. 13 along the path C [with a corresponding increase in total pressure] by the mass flow controller 16a". (See, for example, Page 33, Lines 23-26, and Claims 20, 21, 36, 37, 63, and 70).

In particular, Applicants respectfully submit that determination of the condition in which plasma ignition is possible for a plasma generator while using a mixed gas of Ar and $NF_3$ or $F_2$ ***has been an extremely difficult problem*** because of the generally increasing tendency of the power needed for plasma ignition. As explained in the present application, there arises a problem of difficulty of plasma ignition in a remote plasma source when an etching gas containing fluorine having large electronegativity, such as $NF_3$, is added to Ar gas in the remote plasma source. (See, for example, Page 8, Lines 23-28).

Applicants further respectfully submit that plasma ignition in an Ar-free flow of $NF_3$ (or with a minor carrier gas), as disclosed by Sorensen, is only possible logically or theoretically. In particular, plasma ignition in an Ar-free flow of $NF_3$ (or with a minor carrier gas), as disclosed by Sorensen, is, in fact, unrealistic as it requires a very large high frequency power, which results in the situation that a large voltage is applied to the coil until the ignition of the plasma. Once the plasma has been ignited, there is caused a very large change of voltage and current in the coil of the plasma generator, and it becomes necessary to control the voltage and current appropriately for stabilization of the plasma while taking into consideration the limitation about the electrical system used for driving the plasma generator. With decrease of the proportion of the Ar gas in the mixed gas, this problem appears conspicuously, and without any Ar

gas, it is hard to cause dissociation of F and no stability is attained for the plasma.

Sorensen is silent about this problem of stability of the plasma and the stability of the driving system. Thus, Sorensen is also silent about the presently claimed features of **(1)** supplying a mixed gas of an Ar gas and a fluorine-containing species (*e.g.*, $NF_3$ or $F_2$) containing at least 5% of the fluorine-containing species (*e.g.*, $NF_3$ or $F_2$) in terms of flow rate, igniting plasma by driving the coil with a high-frequency power, and increasing, after the step of igniting plasma, a total pressure of the mixed gas while maintaining the plasma; and **(2)** the step of igniting being conducted under a total pressure of 6.65-66.5Pa. The problem inherent with Sorensen of instability of plasma ignition and possible damage to the driving system is successfully avoided. In relation to this, the presently claimed methods also allow the use of inexpensive driving system for driving the toroidal plasma generator.

The Office Action asserts that "any amount of argon would have made plasma ignition easier according to Sorensen". (Pages 4-5). However, Sorensen merely discloses that a ***minor*** carrier gas may help initiate and/or stabilize plasma. (See Page 4, Paragraph [0042]).

With regard to the alleged non-criticality or lack of unexpected results for the claimed range, Applicants respectfully submit that the claimed range is ***not*** predicted and has been discovered by the present Applicants. Applicants respectfully submit that the claimed range provides unexpected results.

A prior art reference must be considered in its entirety, i.e., as a <u>whole</u>, including portions that would lead away from the claimed invention. *W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851 (1984); MPEP § 2141.02.

Applicants respectfully submit that, contrary to the assertion in the Office Action, Selbrede does not disclose or suggest, after igniting plasma, ***increasing*** the pressure, concentration, or flow rate of mixed gas, fluorine-containing species (*e.g.*, $NF_3$ or $F_2$), cleaning gas, or etching gas, ***while maintaining the plasma***, as presently claimed. In fact, Selbrede discloses that because the power required to

ignite and ***sustain*** a plasma in the RPC chamber is a function of the pressure of the gas from which the plasma is generated, ***lowering the pressure*** within the Remote Plasma Cleaning (RPC) chamber reduces the power required ***to sustain the plasma***. (See Page 5, Paragraph [0048]). Thus, Applicants further respectfully submit that Selbrede, actually teaches away from, after igniting plasma, ***increasing*** the pressure, concentration, or flow rate of mixed gas, fluorine-containing species (*e.g.*, $NF_3$ or $F_2$), cleaning gas, or etching gas, ***while maintaining the plasma***, as presently claimed.

Figure 12 of Selbrede merely discloses that the plasma generator operates at approximately 250 watts when no $NF_3$ is present and that the power is increased to about 2700 watts when the $NF_3$ is increased from 10sccm to 1000sccm. There is no disclosure in Selbrede to ignite plasma in a mixed gas of Ar and $NF_3$ with specific gas composition for the Ar/$NF_3$ mixed gas as set forth in the present claims. Further, a person skilled in the art would be motivated, in view of Sorensen and Selbrede, to ignite the plasma in an Ar gas free from $NF_3$ as is practiced conventionally in the art and in contrast to the present claims.

Steinwandel discloses that it is possible to superimpose a brief high-frequency pulse on the stationary excitation field or to ***reduce pressure*** in order to ignite the plasma (breakdown). (See Column 5, Lines 55-58). Applicants respectfully submit that, contrary to the assertion in the Office Action, the mere disclosure of Steinwandel of (1) superimposing a brief high-frequency pulse on the stationary excitation field or (2) ***reducing pressure*** in order to ignite the plasma (breakdown), does not suggest or suggest, after igniting plasma, ***increasing*** the pressure, concentration, or flow rate of mixed gas, fluorine-containing species (*e.g.*, $NF_3$ or $F_2$), cleaning gas, or etching gas, ***while maintaining the plasma***, as presently claimed.

Accordingly, Applicants respectfully submit that Sorensen in view of Selbrede and Steinwandel does not disclose or suggest the presently claimed features of **(1)** supplying a mixed gas of an Ar gas and a fluorine-containing species (*e.g.*, $NF_3$ or $F_2$) containing at least 5% of the fluorine-containing species (*e.g.*, $NF_3$ or $F_2$) in terms of flow rate, igniting plasma by driving the coil with a

high-frequency power, and increasing, after the step of igniting plasma, a total pressure of the mixed gas while maintaining the plasma; and **(2)** the step of igniting being conducted under a total pressure of 6.65-66.5Pa.

Applicants respectfully submit that Raaijmakers merely disclsoes switching of the mass flow controller (MFC) from a first MFC of larger capacity (300sccm) used for a higher pressure (P0) to a second MFC of smaller capacity (20sccm) used for a lower pressure (P1). (See Column 6, Lines 61-65). Further, Raaijmakers is silent about maintaining plasma during the phase of switching the MFCs.

In contrast to Raaijmakers, the present application teaches the switching of the MFCs in the opposite way from the first MFC of smaller capacity to the second MFC of larger capacity. Thereby, the plasma is maintained during this phase of switching of the MFCs. Raaijamkers is silent about this feature of switching a mass flow controller used to supply fluorine-containing species (*e.g.*, $NF_3$ or $F_2$) from a first mass flow controller having a first capacity to a second mass flow controller having a second capacity larger than the first capacity, the step of switching the mass flow controller being conducted while maintaining the plasma, as set forth in the present claims.

Further, in relation to the foregoing arguments with regard to Raaijmakers, Applicants again point out that Selbrede teaches away from, after igniting plasma, increasing the pressure, concentration, or flow rate of mixed gas, fluorine-containing species (*e.g.*, $NF_3$ or $F_2$), cleaning gas, or etching gas, while maintaining the plasma, as set forth above.

Accordingly, Applicants respectfully submit that independent claims 1, 11, 63, and 77, 79, and 80-82 are patentable over the proposed combination of Sorensen, Selbrede, Steinwandel, and Raaijmakers, and respectfully request the withdrawal of the rejection of claims 1-4, 6-10, 63-65, 67-69, 77, 79, 80, 81, and 82 over Sorensen in view of Selbrede, Steinwandel, and Raaijmakers.

The rejections of: **(1)** claims 6-8, 17-30, 33, 49-51, 53-55, 66, 70-72, and 74-76 were rejected under 35 U.S.C. § 103(a) over Sorensen in view of Selbrede, Steinwandel, and Raaijmakers and further in view of U.S. Patent No. 5,288,971

("Knipp"), **(2)** claims 11-12 and 78 were rejected under 35 U.S.C. § 103(a) over Sorensen in view of Selbrede, Steinwandel, and Raaijmakers and further in view of U.S. Patent Application Publication No. 2002/0000198 ("Ishikawa"), **(3)** claims 31-32 and 52 were rejected under 35 U.S.C. § 103(a) over Sorensen in view of Selbrede, Steinwandel, Raaijmakers and Ishikawa and further in view of Knipp, **(4)** claims 14-16 were rejected under 35 U.S.C. § 103(a) over Sorensen in view of Selbrede, Steinwandel, Raaijmakers, and Ishikawa and further in view of Knipp, **(5)** claims 34-46 and 56-62 were rejected under 35 U.S.C. § 103(a) over Sorensen in view of Selbrede, Steinwandel, and Raaijmakers and further in view of U.S. Patent No. 4,662,977 ("Motley") and Knipp, and **(6)** claims 47, 48, and 73 were rejected under 35 U.S.C. § 103(a) over Sorensen in view of Selbrede, Raaijmakers, Motley, and Knipp and further in view of Ishikawa, are each respectfully traversed.

The secondary references of Knipp, Ishikawa, and Motley fail to cure the above-noted deficiencies with regard to Sorensen, Selbrede, Steinwandel, and Raaijmakers. Accordingly, Applicants respectfully submit that independent claims 17, 33, 49, and 70 are patentable over the proposed combination of Sorensen, Selbrede, Steinwandel, Raaijmakers, and Knipp; independent claims 11 and 78 are patentable over the proposed combination of Sorensen, Selbrede, Steinwandel, Raaijmakers, and Ishikawa; and independent claim 56 is patentable over the proposed combination of Sorensen, Selbrede, Steinwandel, Raaijmakers, Motley, and Knipp. Thus, Applicants respectfully request the withdrawal of the rejections of claims 6-8, 17-30, 33, 49-51, 53-55, 66, 70-72, and 74-76 over Sorensen in view of Selbrede, Steinwandel, and Raaijmakers and further in view of Knipp, **(2)** claims 11-12 and 78 over Sorensen in view of Selbrede, Steinwandel, and Raaijmakers and further in view of Ishikawa, **(3)** claims 31-32 and 52 over Sorensen in view of Selbrede, Steinwandel, Raaijmakers and Ishikawa and further in view of Knipp, **(4)** claims 14-16 over Sorensen in view of Selbrede, Steinwandel, Raaijmakers, and Ishikawa and further in view of Knipp, **(5)** claims 34-46 and 56-62 over Sorensen in view of Selbrede, Steinwandel, and Raaijmakers and further in view of Motley and

Knipp, and **(6)** claims 47, 48, and 73 over Sorensen in view of Selbrede, Raaijmakers, Motley, and Knipp and further in view of Ishikawa.

In view of the foregoing, the application is respectfully submitted to be in condition for allowance, and prompt favorable action thereon is earnestly solicited.

If there are any questions regarding this reply or the application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket #010986.57272US).

Respectfully submitted,

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